

The effect of physical activity on the knee joint: is it good or bad?

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Could the promotion of physical activity inadvertently increase the burden of osteoarthritis?

The promotion of physical activity is a major public health initiative in developed countries world wide. Although physical activity protects against a large range of health conditions, including cardiovascular disease, obesity and osteoporosis, it is unclear whether physical activity increases the risk of osteoarthritis (OA). This is of concern given that global estimates indicate that OA is the fourth leading cause of years lived with disability.¹ Moreover, the prevalence and incidence of knee OA, the most common form of this disease, is expected to rise due to the increased life expectancy and consequently aging population. It is therefore possible that health promotion strategies, such as encouragement of physical activity, may inadvertently increase the burden of OA. If promoting physical activity is to continue to be a key, population-wide strategy for the prevention of chronic conditions and the attainment of health benefits, it is important that we understand its effect on weightbearing joints such as the knee.

EVIDENCE FROM CROSS-SECTIONAL AND LONGITUDINAL RADIOGRAPHIC STUDIES

Cross-sectional studies examining the effects of physical activity on knee joint health have yielded conflicting results. Whereas middle-aged physical education teachers ("active community subjects") were reported to have less radiological OA than age-matched controls,² greater rates of radiographic knee OA were found in female ex-elite athletes than in population controls.³

Similarly, the results of longitudinal, radiographic studies differ. For instance, the investigation of a cohort from the Framingham Heart Study found that recreational exercise had no effect on the radiological status of older, healthy adult knee joints,⁴ whereas a prospective cohort study of Australian community-based women demonstrated that the average level of physical activity was

independently associated with the development of radiographic knee OA.⁵

POSSIBLE EXPLANATIONS FOR THE CONFLICTING EVIDENCE

These conflicting data may have arisen for several reasons. First, injury is a major risk factor for the development of OA and although injury was accounted for in regression models, it is possible that residual confounding remained, as those exercising more vigorously were more likely to sustain an injury.

Second, epidemiological studies have defined OA on the basis of clinical symptoms and the radiological presence of joint-space narrowing and osteophytes.³ Although a number of studies have reported a higher prevalence of osteophytes in people exercising more vigorously,³ others have found no change in joint space.⁴ As radiographic studies of joint space may have missed an effect of physical activity, an over-reliance on the assessment of osteophytes in determining the effect of physical activity on the knee joint has resulted.

Third, the beneficial or harmful effects of physical activity may have been overshadowed by the failure of studies to adjust for individual and environmental factors (eg, body mass index), which have been shown to mediate the effects of exercise on the knee joint.

STUDIES USING MAGNETIC RESONANCE IMAGING (MRI) TO EXAMINE KNEE STRUCTURE

A small number of studies have recently used a new technique of MRI to examine the effect of physical activity on the knee joint. This method allows direct visualisation of joint structures, such as cartilage volume, without exposing subjects to ionising radiation. This is in contrast with radiographic measurement of joint-space width, which provides an approximation of articular cartilage, and exposes subjects to unnecessary radiation. Moreover, MRI is recognised as a valid, accurate and reproducible tool for measuring articular

cartilage volume and cartilage defects.^{6,7} The advent of MRI has made it possible to examine the pre-, early and late diseased states of OA, including the progression of disease over relatively short periods of time. These advances provide new opportunities to assess the role of potential risk factors, including physical activity, in the natural history of knee OA.

Recently, two separate cross-sectional community-based studies of healthy adults with no history of knee injury or disease used MRI to assess the relationship between physical activity and knee joint structure. These studies found that increased tibial cartilage volume was positively associated with the frequency and duration of vigorous activity (activity leading to sweating, shortness of breath or an increased pulse rate).^{6,7}

Several longitudinal studies have also used MRI to examine change in knee joint cartilage. Krampla *et al* demonstrated no significant knee structural change in healthy, recreational long-distance runners 6–8 weeks after a marathon.⁸ However, physical inactivity has been shown to affect cartilage development adversely, with less physically active children reported to have reduced knee cartilage and gain less cartilage over 2 years than active children.⁹ Similarly, adults who become quadriplegic show rapid cartilage loss within the initial 12 months of quadriplegia.¹⁰

Overall, recent cross-sectional and longitudinal MRI studies suggest that physical activity benefits articular cartilage at the knee.

WHAT MIGHT BE THE MECHANISM BY WHICH PHYSICAL ACTIVITY AFFECTS KNEE CARTILAGE?

The effect of physical activity on knee cartilage may relate to the effect of loading on the joint. Deformation of tibiofemoral cartilage has recently been demonstrated immediately after high-impact loading.¹¹ Similarly, cartilage in athletes has been found to be more deformable than that in non-athletic controls,¹¹ although previous studies suggest that athletes have more knee cartilage than controls.¹² The relationship between physical activity and cartilage volume may therefore be the result of complex mechanocellular transduction mechanisms. It has been speculated that chondrocytes may respond to mechanical loading by increasing glycosaminoglycan content after exercise, causing a "swelling" of cartilage. This may represent a compensatory mechanism to withstand added joint loads.¹³ Thus, it may be that people who participate in regular physical activity enhance the metabolic activity of cartilage, which may equip articular

cartilage with better self-repair mechanisms that are otherwise absent in those who are sedentary.¹⁴

FUTURE RESEARCH: WHERE TO FROM HERE?

Further high-quality, well-designed research is urgently needed to examine the relationship between physical activity and knee OA. Prospective cohort studies are recommended as they allow change in joint health to be measured over time and avoid the ethical concerns of exercise cessation in control participants and problems with exercise compliance over long periods. Participants who have a previous history of injury or pain at the knee joint need to be excluded, and environmental and individual factors which may mediate the effect of physical activity need to be examined. In conjunction with radiological methods, the use of new MRI techniques need to be considered in determining the effect of physical activity on knee structures such as articular cartilage.

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